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by

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Zhang Yaping

1993 marks the tenth year of the Strategic Defense Initiative (SDI) project in the United States. In this year, major adjustments were conducted in SDI. After the adjustments, the project was renamed Ballistic Missile Defense (BMD), thus further showing the reality of theater missile defense. The project was transformed from systems research to systems deployment and purchase.

After the project was renamed BMD, the sequence of key development was as follows: 1. theater missile defense system; 2. nationwide missile defense system; and 3. antimissile advanced technical research, including brilliant pebbles, directed-energy weapons technology, and electromagnetic gun technology (among others), as the successor systems.

After the directed-energy technology was listed as a successive system, the former Strategic Defense Initiative Organization (SDIO) revealed a trend of gradually cutting back on annual research expenditures on the project: 263 million U.S. dollars in fiscal year 1992; 162 million dollar in fiscal year 1993; and 100 million dollars in budgetary requests in fiscal year 1994. However, the following points are noteworthy: 1. in 1993, the SDIO transferred several laser weapon projects to

various branches of the armed forces. In key development projects, additional allocations have been obtained from these various armed forces branches. 2. The chemical laser project was still a key development in fiscal year 1994 as the vast majority of funds in the directed-energy weapon was allocated to the chemical laser project. In May 1993, in a report forwarded to the Congress by the deputy secretary Perry of the U.S. Defense Department: "Except for space phase applications, the additional applications in the near term of five to seven years include a mobile land-based lasers, shipborne anti-cruise missile lasers, and point defense lasers. These applications will follow the research on chemical lasers proceeding at present."

In 1993, the BMDO was still evaluating six reserve schemes on tactical ballistic missiles for booster-stage interception, including three laser weapon schemes: space-based (satellite platform), large widebody aircraft-borne (Boeing 747), and drone-borne (Bald Eagle) laser weapon schemes.

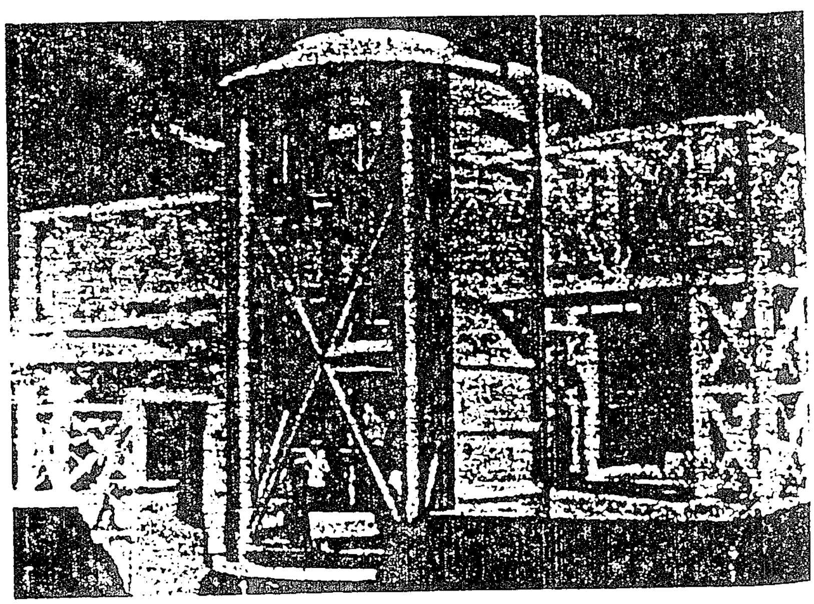

Fig. 1. Megawatt-level alpha chemical laser device

Viewing the 1993 development in the directed-energy weapon field, we can discern the following features: 1. development of theater defense laser weapons was particularly emphasized; the development will have priority. 2. The key to strategic defense laser weapons is still the space-based alpha chemical lasers, and 3. development of laser weapons has been given growing emphasis by the various branches of the Armed Forces,.

I. Some Adjustments to, and Continued Progress in the Strategic Defense Directed-Energy Weapon Project

1. Technology of the space-based alpha chemical laser has matured with the continuous developments.

At present, high-quality light beams at the megawatt power level were realized for the space-based alpha chemical lasers. In wide-ranging experiments in 1993 on alpha-large advanced reflective mirror project (ALI), very marked progress was achieved; 85% of the experimental facilities have been completed; 80% of the hardware required for high-powered wide-ranging experiments was fabricated or has entered the final manufacturing stage. Forty percent of software development was completed as required by the high-powered wide-ranging experiments. The progress is ahead of schedule. It was planned in the summer of 1994 to transport the hardware required for the experiment to Kapisteno Proving Grounds of the TRW. Experiments will begin in mid-1996.

Although the SDIO was renamed BMDO in 1993, the deployment of space weapons was cancelled; however, as stressed by the U.S. Defense Department the space deployment of alpha chemical lasers will be possible to counteract the possibly growing threat from ballistic missile strike carrying chemical and biological warheads. Only with sufficient funds and political backing can experiments on space lasers can proceed within 7 years. Within 15 years, space-based chemical laser weapons as defense against ballistic missiles can be developed.

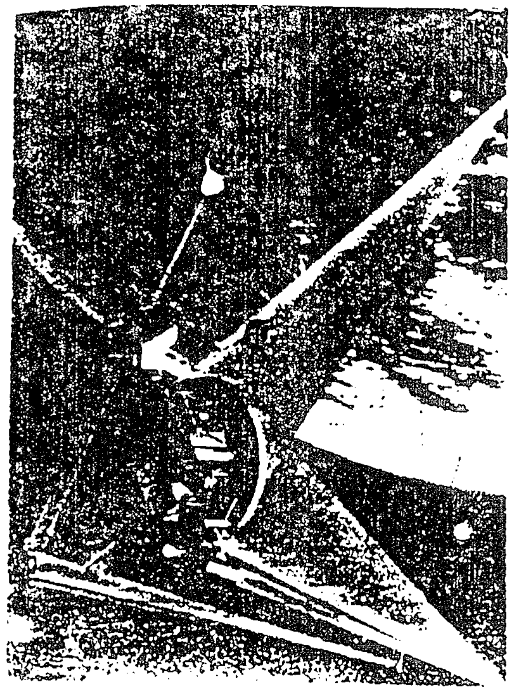

Fig. 2. In-orbit relay reflective mirror

2. Funds for the free-electron laser project were exhausted so the project was forced to be suspended.

In late 1990, the free-electron laser project was transferred to the Average Power Laser Experiment (APLE) project. Thereupon, in 1992, two major subsystems (injectors and light cathodes) attained important technical progress for the APLE project. Since then, in the first half-year of 1993, the SDIO transferred the project to the U.S. Army.

As reported on June 30, 1993, in a memorandum of the Space and Strategic Defense Headquarters of the U.S. Army, due to a lack of appropriations to continue this project in fiscal year 1994, any additional appropriations to the project will not be forthcoming in fiscal year 1993., therefore the APLE contract on free-electron lasers signed with the Boeing Corporation will be terminated on June 30, 1993. The U.S. Army terminated the APLE research on June 30, 1993.

3. Key research on neutral particle beams has been turned to target discrimination technology. Cooperative research in this field was intensified by the United States and Russia.

It is still early to use neutron particle beams (NPB) as a weapon. The main targets of the intermediate- and near-term in the research is to use neutron particle beams to discriminate real from false warheads.

Notwithstanding that research funds in this field were declining in recent years with 75 million U.S. dollars in the budget of fiscal year 1992, 39.2 million dollars budgeted for fiscal year 1993, and 25.5 million dollar budgetary requests in fiscal year 1994, however, from official announcements that research activities will continue in fiscal year 1994 on the continuous-wave deuterium demonstration device at the Argonne National Laboratory, and land-based experiments on accelerators at the Los Alamos National Laboratory.

In another report, from 1992 and 1993 after the United States and Russia exchanged visits on the facilities of neutron particle beam facilities, both sides discussed the problems of cooperative research. In the United States' view, it is possible that NPB research could be one of the first selected technical fields in the United States-Russia cooperative research. The Russian side expressed great interest in the cooperative research, and it is possible to provide some technologies to the project, including ion accelerators, engineering technology in aerospace carrier flight vehicles, prime mover systems, radio-frequency power systems, radiation probes, and ion propulsive device technologies. It is possible to have another NPB space experiment with the cooperation between the United States and Russia.

4. The research project of the nuclear directed-energy technology of SDI was been suspended; the United States Department of Energy continues this research.

In 1992, the SDIO terminated the research on nuclear

directed-energy weapons; however, the Department of Energy still continued to develop research in this field in order to evaluate whether these new concepts will have what kind of potential effect exerted on the present strategic intimidation or the future strategic defense system structure in order to better determine the research scope of the nuclear directed-energy weapons of the former Soviet Union. This most recent information of evaluation will have effects on the means of nuclear directed-energy weapons possibly adopted in the future.

5. The experimental project of the Star Ball Laboratory was finally changed into balloon-carrying experiments. The experimental period has been scheduled.

After adjustments were made twice, in 1991 and 1992, the expected expenditure of 1 billion United States dollars experimental project of the Star Ball Laboratory conducted in the United States Space Shuttle was finally changed into a lower-cost balloon-carrying experiment. In early 1993, the experimental schedules of the High-Altitude Balloon Experiments (HABE) were the responsibility of the Philips Laboratory of the United States Air Force. The first experiment was scheduled on May 3, 1993. In mid-May, another experiment was held regarding balloon-carried experimental payload of simulated optical components rising to the peak height of 29.9km. In late May, ground experiments utilizing planets and satellites for experiments on optical components were performed. In early June, the first flight experiment carrying optical components was conducted in order to make correct readings of instruments by referring to satellites and planets. In late June, the system was experimented on 50 to 100 targeting rockets. If the experiments prove successful, in early September HABE will conduct the first observations on actual experiments for the launch of Black Brant 9 rocket. All the above-mentioned experiments were conducted in the White Sands Missile Range. Because of reduced budget, the maritime launch project of HABE will be delayed by a year.

6. The United States and Russia will jointly develop research on plasma.

On April 1, 1993, as reported in Izvestiya in Russia, Russia proposed to jointly conduct with the United States a plasma technical experiment on Kwajalein Missile Range of the United States. The plasma project has the code name Trust; the project is preparing to proceed from laboratory research to overall experiments. However, in coping with the real targets, such as ballistic missiles or supersonic aircraft, the overall experiments still require large funds, estimated to be approximately 300 million U.S. dollars.

As announced by Russia, they are willing to provide their important progress and achievements in fabricating high-powered laser generators and plasma gas-dynamics devices. However, they required that the United States provide related technologies on solid-state electronics and computer.

II. Theater Defense and Tactical Air Defense Laser Weapons Are Emphasized. Progress Is Striking.

1. The United States Air Forces began to demonstrate and verify the aircraft-borne laser antimissile defense project.

In 1992, the large wide-body aircraft-borne (such as Boeing 747) laser weapon project was assigned to the Philips Laboratory of the United States Air Force by the SDIO in 1992, the project was formally transferred in early 1993 to the United States Air Force. Funds amounting to 500 million United States dollars was acquired from the U.S. Air Force.

On June 30, 1993, competitive bidding was announced by the U.S. Air Force for demonstration and verification of aircraft-borne laser anti-theater ballistic missile weapon. It is prepared to spend eight years and 800 million U.S. dollars to fabricate and experiment on the deployable prototype of such weapon in order to verify the technology required for the use of laser weapons to lock on, track, and destroy theater ballistic missiles (with range between 120 and 3000km) in booster-stage

flight.

According to the U.S. Air Force concept, the initial scheme of the aircraft-borne laser weapon system is as follows: passive infrared sensors are used to detect the target, and high-powered chemical lasers are used as the means of destruction, to be combined with the combat management, command, control, and communication to be installed in a Boeing 747 widebody aircraft to constitute a complete combat system. In the initial stage, it is possible to adopt large high-powered chemical oxygen iodine lasers (COIL).

In August 1993, two corporation teams formally submitted proposals under competitive bidding on the project to the Air Force. One team was led by Boeing Corporation, including the TRW Corporation and Lockheed Corporation. Another team is led by Rockwell Corporation, including the E Systems Corporation and the Hughes Aircraft Corporation, among others. The Air Force planned to sign contracts with both teams in January 1994. Through competition of both teams, in 1996 a team will be selected as the main contractor for a contract demonstrating a prototype to be responsible for development of the demonstration prototype system. After the initial design assessment in fiscal year 1997 and the key design assessment in fiscal year 1998, experiments will be conducted on intercepting ballistic missiles in the booster stage. By the end of this century, a decision will be made on whether or not to build or deploy the aircraft-borne laser antimissile defense system.

It was reported that the funds for each contract is between 15 and 18 million United States dollars in the initial stage for decision-making on both schemes. The contract on demonstrating the prototype in the second stage costs approximately 500 million U.S. dollars. The contract in the final stage for the engineering and manufacturing development (EMD) stage is estimated to be in the billions of U.S. dollars.

For smooth progress in the aircraft-borne laser weapon project, the Air Force prescribed a detailed plan for risk

reduction. Beginning in 1992, experiments on reduced risk were conducted. Both teams in the competition are required to submit their risk reduction plans. Once the demonstration and verification stage begins, the winning contractor will be responsible for most tasks in risk reduction.

2. The United States Army intends to adopt a scheme of drone-borne small laser weapons.

The Space and Strategic Defense Headquarters of the United States Army intends to build high-altitude drones capable of carrying modern new-generation lasers. As announced by this headquarters, the drone-borne laser weapon scheme with code name "Light of Defenders" is based on the advanced small solid-state laser device from the Lawrence Livermore Laboratory. The purpose of this project is to use drone-borne laser weapons to shoot down Nike-Ajax missiles not long after their launch. The laboratory will provide a weapon system for the U.S. Army to eliminate the theater ballistic missile threat. Developed by the Lawrence Livermore Laboratory, breakthrough progress was attained in 1992 on a small diode pumped laser device. It was reported that, with help from some related technologies in Russia, the power will be dramatically increased form 1000W at present to several megawatts, capable of use as an effective near-range weapon.

3. The United States Navy intended to conduct demonstration and verification experiments on shipborne laser weapons.

There have been more than two decades for the development of high-energy laser weapon systems (HELWS) in the United States Navy. Major progress was attained in the development of laser devices and their peripheral systems. Large numbers of analytical designs, as well as static and dynamic experiments were conducted. After multiple design-to-manufacture-to-experiment cycles, the technology and engineering development have matured.

To reduce the size of present-day laser weapon systems to

make them suitable for shipborne applications, it is prepared to use turbofan jet engines as the pressure restoration system; exhaust gases from the engine to discharge the low-pressure, high-temperature exhaust gases from the combustion in laser devices to the atmosphere. Moreover, highly-pressurized stored fuel was adopted.

At present, the U.S. Navy is discussing and verifying the feasibility of the demonstration and verification experiments of shipborne high-energy laser weapon systems to begin in 1995; this means the final solution to some remaining problems related to applying the system to ship defense, thus verifying the combat performance of high-energy laser weapon systems in the shipborne environment.

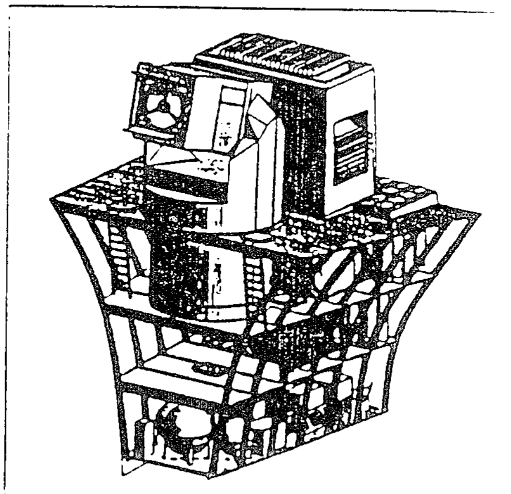

Fig. 3. Block diagram of shipborne high-energy weapon system

4. The U.S. Army authorized research into integrated theater defense antimissile system.

In October 1992, the U.S. Army granted a research contract to the TRW Corporation of 168,000 U.S. dollars, over a nine-month period, to study the integrated theater defense antimissile system. Feasibility of the laser air defense weapon system is mainly assessed. It was reported that the system used intermediate-powered laser devices installed on heavy military chassis to send laser beams releasing a temperature corresponding

to that on the sun's surface, capable of destroying targets in flight 15km distant. As told by related personnel in the TRW Corporation, since the first experiments on the system in 1977, the kill probability was 100%. The spokesman further added that the system will be prepared to be installed in C-130 transports, carrying only the fuel required for 60 seconds of launch time or destroying nearly 50 targets.

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